We claim:

1. A semiconductor resonator structure comprising:

a light transmissive substrate;

a guiding channel defined in the substrate; and

at least two distributed gratings defined in the substrate surrounding the guiding channel by at least two opposing sides of the guiding channel, wherein either the period of each of the gratings or their refractive index or both are not constant.

2. The structure of claim 1 wherein the channel has an external side and an internal side and where the gratings disposed on the external and internal sides are different.

3. The structure of claim 1 wherein the gratings have an index profile given by $n(\rho) = n_{eq}(\rho)\, R/\rho$ and $n_{eq}(\rho = R \exp(U/R))$ has a conventional Bragg grating index profile, where ρ is the radial polar coordinate, $n(\rho)$ is the real index of refraction as a function of ρ, $n_{eq}(\rho)$ is the equivalent index of refraction as a function of ρ, U is a transformational coordinate given by $\rho = R \exp(U/R)$, and R is an arbitrary constant.

4. The structure of claim 1 wherein the gratings are Bragg gratings comprised of layers with a width, $w = u_2 - u_1$, determined according to

$$\frac{\pi}{2} = \int_{u_1}^{u_2} \sqrt{k_0^2 n_{eq}(u)^2 - m^2/R^2} \cdot du$$

where ρ is the radial polar coordinate shown as the integration variable u above, k_0 is the wave number in vacuum of the light propagating in the structure, $n_{eq}(\rho)$ is the equivalent index of refraction as a function of ρ, *m* is a predetermined azimuthal number, *R* is the radius of the internal edge of the grating, u_1 and u_2 are respectively the initial and end radii of a Bragg layer in the grating.

5. The structure of claim 1 wherein the shape of the resonator is circular.

6. The structure of claim 1 wherein the shape of the resonator is oval.

7. The structure of claim 1 wherein the index of refraction of the guiding core is smaller than the index of refraction of the surrounding distributed gratings.

8. The structure of claim 2 wherein the index of refraction of the guiding core is smaller than the index of refraction of the surrounding distributed gratings.

9. The structure of claim 1 wherein the distributed gratings are made of dielectric material.

10. The structure of claim 1 wherein at least part of the substrate is "active" and able to provide optical gain.

11. The structure of claim 1 wherein the distributed gratings are comprised of alternating index layers.

12. An optical resonator with large free spectral range (FSR) and low losses comprising:

an optical substrate;

a guiding channel defined in the substrate; and

at least one radial Bragg reflector adjacent to the guiding channel to confine light therein.

13. The optical resonator of claim 12 where the guiding channel and adjacent radial Bragg reflector form a combination with radial structure, is a combination characterized by a profile of the refractive index, which profile is a periodic function superimposed on a decreasing function of radial position.

14. The optical resonator of claim 13 where the Bragg reflector is comprised of a plurality of radial layers having a distinct refractive index from the refractive index of the substrate, where the plurality of radial layers have an internal edge, and where the width of each layer is selected so that constructive interference of all partial reflections from the plurality of layers is obtained at the internal edge of the Bragg reflector.

15. The optical resonator of claim 14 where the optical resonator has a resonant frequency of light, where each layer of the Bragg reflector has a thickness and where the thickness of each layer is greater than the constant Bragg thickness for reflector at the resonant frequency of light and decreases asymptotically toward the constant Bragg thickness as the distance of the layer away from the guiding channel increases.

16. The structure of claim 15 wherein the thickness of each layers is $w = u_2 - u_1$, determined according to

$$\frac{\pi}{2} = \int_{u_1}^{u_2} \sqrt{k_0^2 n_{eq}(u)^2 - m^2/R^2}\, du$$

where ρ is the radial polar coordinate shown as the integration variable u above, k_0 is the wave number in vacuum of the light propagating in the structure, $n_{eq}(\rho)$ is the equivalent index of refraction as a function of ρ, *m* is a predetermined azimuthal number, *R* is the radius of the internal edge of the grating, u_1 and u_2 are respectively the initial and end radii of a Bragg layer in the grating.

17. The optical resonator of claim 12 where the guiding channel is characterized by a low index of refraction.

18. The optical resonator of claim 12 where the guiding channel forms a closed loop.

19. The optical resonator of claim 12 where the guiding channel has an external side and an internal side, and where the at least one radial Bragg reflector is comprised of at least two radial Bragg reflectors, a first one of the two radial Bragg reflectors is disposed on the external side of the guiding channel

and adjacent thereto and a second one of the two radial Bragg reflectors is disposed on the internal side of the guiding channel and adjacent thereto.

20. The optical resonator of claim 12 further comprising means for pumping the guiding channel.